NASA TT F-9799

# NOISE PROBLEM

I.Borshchevskiy and E.Lapayev



Translation of "Problema shuma".
Aviatsiya i Kosmonavtika, Vol.48, No.7, pp.75-77, 1965.



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON DECEMBER 1965

# NOISE PROBLEM



I.Borshchevskiy* and Major E.Lapayev**

13297

A brief general review of the detrimental effect of noise of a certain intensity on the human organism, specifically on the auditory organs, is given, with diagrams on noise levels with and without engine exhaust silencers and descriptions of earplug and earcap designs. Hearing loss of flying crews in jet aircraft and spacecraft is considered transitory, while permanent damage is expected in unprotected maintenance crews. Soundproof rooms on airfields for rest periods of crews are suggested.

The "winged" phrase "The noise of a running engine was sweeter to him than the entrancing sounds of a symphony" is often encountered in literature. Is this really so? We shall answer this question with an example.

The Summer day is past. Through the open windows of the classroom the cool of the dusk comes in, with the wafted aroma of the steppes. The commander has just reviewed the flights of long-distance rocket carriers. It was pleasant to hear how all of the crews had accomplished their missions with the mark of "excellent". But now at the distant airfield an engine has been started. The neighbors are getting their aircraft ready for a night flight. A few men stood up right away. Involuntarily grumbling, they shut the window.

---

* Candidate in Medical Sciences.

** Medical Service.

*** Numbers in the margin indicate pagination in the original foreign text.

What was it that made these veteran aviators shut the window and prefer sitting in a stuffy room? The noise of the running engine. And not because it drowned out the commander's voice. Importunately it thrust itself on their ears, irritated them, and distracted their attention. Even a cherished melody sounds unpleasant when the radio is going full blast. But is noise really as harmless as it seems at first glance?

Noise has an unfavorable effect on the human organism. Its consequences depend primarily on duration and intensity. How serious are these consequences?

The slight hearing loss observed in some people develops from a cumulative effect of small but frequently recurring chronic irritations of the organs of hearing. Under certain conditions, given individual instability, such influences exerted by noise may lead to severe hearing loss.

The protracted action of high-intensity noise may also lead to functional disorder of the vestibular apparatus. Cases have been observed in which, under these conditions, there are changes in visual acuity, in respiration and pulse rate, in blood pressure, and in the volume of spleen and kidneys. The number and amplitude of contractions of the human stomach likewise decline. After prolonged exposure to noise some workers complain of insomnia, headache, fatigue, and loss of appetite. Using the same amount of energy, the productivity of labor in noisy surroundings is substantially lowered.

Measurements and theoretical calculations of the noise of rocket engines and spacecraft have recently been published. Thus, according to data of certain authors, the noise level of a rocket engine may exceed 170 db. The noise spectrum has a maximum intensity in the frequency range of 300 - 600 cps. The total noise level on the surface of a rocket nose on blastoff has a continuous spectrum in the range of 145 - 150 db.

The turbulence of the boundary layer (aerodynamic noise) is a considerable source of high-frequency noise in a spacecraft. /76 In flight outside the atmosphere, noise in the cabin comes only from transmission of the vibrational energy of the engines through the structure of the craft, and from the life support systems. The influence of such noise, however, is relatively minor.

The acoustic conditions in a spacecraft can be calculated in advance with an accuracy sufficient for analysis of the physiologically allowable noise levels for astronauts. It may be assumed that noise will not be a harmful factor for a healthy human subject during space flights if, in laying out the cabin, sufficient attention has been paid to its resonance characteristics and if a maximum of modern acoustic insulation and sound-absorbing materials have been used.

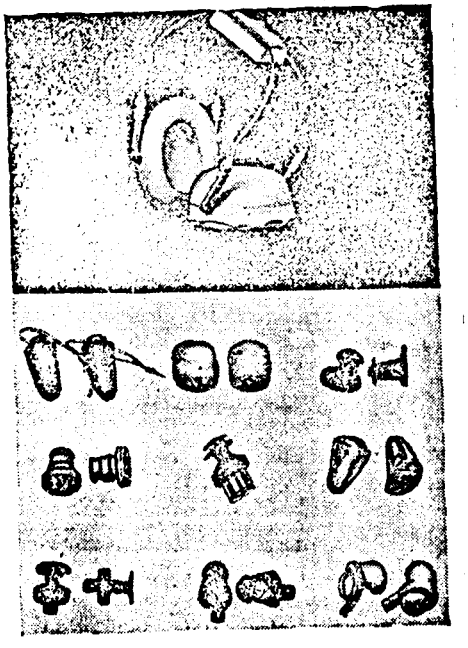

Fig.1 Specimens of Noise-Protective Earcaps and Earplugs

The noise level in the cabin of a modern jet aircraft reaches 85 - 100 db. However, intercom helmets and hermetically sealed helmets considerably diminish

the effect of noise.

Repeated studies of hearing have shown that, while there exists a certain dependence of the hearing loss of flight personnel on flying time, its magnitude is highly arbitrary. Here, individual peculiarities have a greater effect. Thus, in some subjects examined, a hearing loss can be detected after a relatively short flight. On the other hand, there are flyers with relatively good hearing in spite of a long tour of flight duty.

Obviously, impairment of hearing in flight personnel consists usually of a brief, unstable, and minor hearing loss after a given flight. Within 2 - 3 hrs, and sometimes even sooner, all these manifestations disappear without leaving a trace.

The situation is somewhat different for engine maintenance crews. In preparing the engines for flight, these men spend a long time on the airfield on engine testing, when the noise level is very high.

To avoid the harmful action of aircraft noise on flight personnel, and especially on maintenance crews, noise control measures are usually taken. What are they?

Primarily, there are individual antinoise measures (noise protectors). Depending on the noise level, the working conditions, and the individual medical history, noise protectors of various types are used. Intercom helmets and sealed helmets are the most effective and acceptable means for flight personnel.

For engineering and technical personnel in the spring and summer period of airfield work, we recommend noise protectors consisting of two-piece earmuffs (Fig.1). In the autumn and winter period, it is preferable to use intercom helmets of leather, canvas, or textovinyl (a leatherette) of conventional design or of a lightweight type with earcaps. In either case the earcaps, of sound-

absorbing materials, should fit snugly against the ear and the surrounding area. For communications personnel, stationed at engine-testing centers, the earcaps and intercom helmets are equipped with telephones.

In addition to individual noise protectors, plugs of various types are also used to close the external auditory channel (cf. Fig.1). These are made of ebonite, Plexiglas, or hard rubber and are designed for brief or extended use. Naturally, such plugs must be individually fitted. They must neither press /77 on the cochlea or outer auditory channel nor irritate the skin.

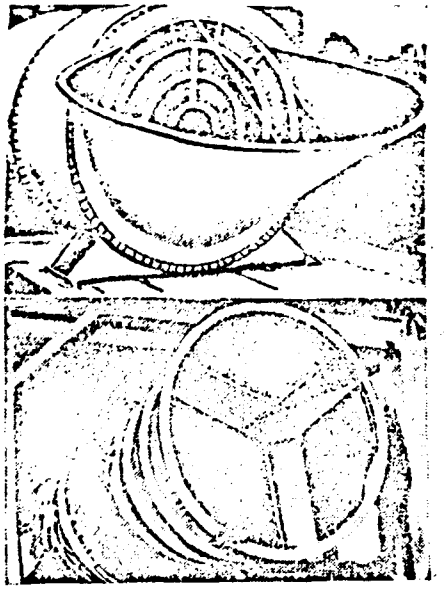

Fig.2 Segmented Silencers for the Exhaust Nozzle of a Jet Engine

However, airfield noise control cannot be restricted to the use of individual protective devices. Their muffling power is insufficient, ranging from 10 to 20 db. Predominant importance, in the group of measures against aircraft noise, to judge from the literature, is given to special technical devices, mainly to silencers.

Silencers are of simple design, consisting of metal cylinders of constant

or variable cross section. Some types of silencers end in a divergent elbow which still further lowers the sound level at low and moderate frequencies. Many designs provide for sections with noise-absorbing grids or special devices. A large number of different silencer designs is in existence (Figs.2 and 3).

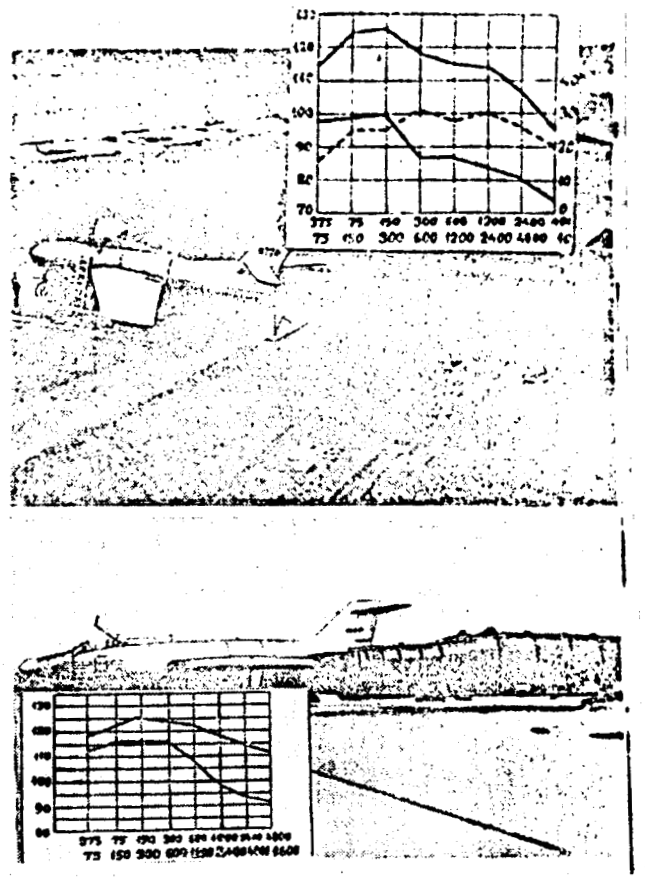

Fig.3 Mobile Silencers at the Airfield.
The graphs show the noise level: upper curve, without silencer; lower curve, with silencer; dashed line, muffling effect.

Mobile silencers that can be maneuvered on the airfield are considered the most convenient in operation. Such silencers, assembled from separate units, have their own motive power and special mechanisms for adjusting their height longitudinally and transversely.

Good organization of flight preparation of the equipment as well as de-

velopment and strict observance of standard operating procedures for engineering and technical airfield personnel are considered no less important in the campaign to diminish the harmful effect of aircraft noise. Here, the primary role is played by the supervisory personnel of the Aviation Engineering Service, and by the medical personnel. It is advisable to designate a small group of specialists necessary for engine testing. All others should be in shelters during the testing period. Short breaks in the work, for rest in quiet rooms are very useful. Toward this end, airfield layouts should provide for soundproof rooms.

Good labor organization, in conjunction with individual and collective protective devices, will be entirely adequate to protect the flight and engineering-technical personnel from the harmful action of aircraft noise.